Draft Falloff Test Design

Stasta No. 1

Wilzetta Field
Lincoln County, OK

Prepared by EPA Region 6

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Background

- Charles Lord with OCC contacted R6 to design a falloff test procedure to identify faults near disposal wells
  - Disposal wells were Stasta Nos. 1 and 2
- OCC provided a fault map and available permit and injection data on the wells
- Information on some offset wells was also received
- Nancy Dorsey located additional information:
  - Neutron Density log for the New Dominion Stevens #1 located in SE NW Sec 7-15N-2E, Lincoln Co., OK
  - AAPG paper on the Hunton formation of OK and TX

Summary

- **Sealing fault will result in the doubling of the semilog straight line and therefore doubling of the derivative on the log-log plot**
  - **To see a fault response on the log-log plot, the injection and shut in test times must exceed the time to reach the fault and allow sufficient time for the pressure response to be observed back at the test well**
  - **Response time is shorter for higher permeable reservoirs**

Summary

- R6 staff used PanSystem pressure transient software
- Simulations based on different scenarios
  - Faults located at 250’ and 1000’ from the well
  - Permeabilities of 10 and 20 md
    - Show impact that the reservoir transmissibility on the derivative responses
  - Injection times of 100 and 1000 hrs
  - Falloff times of 100 and 300 hrs

Falloff Test Considerations

- Must use downhole pressure gauge if well may go on a vacuum during the falloff test
- Rate changes in direct offset wells(injection or producing) completed in the same formation may influence results
  - Monitor injection rates in these offset wells prior to and during the falloff test
  - Consider obtaining fluid levels in any shut in offset wells completed in the same formation prior to and during the test

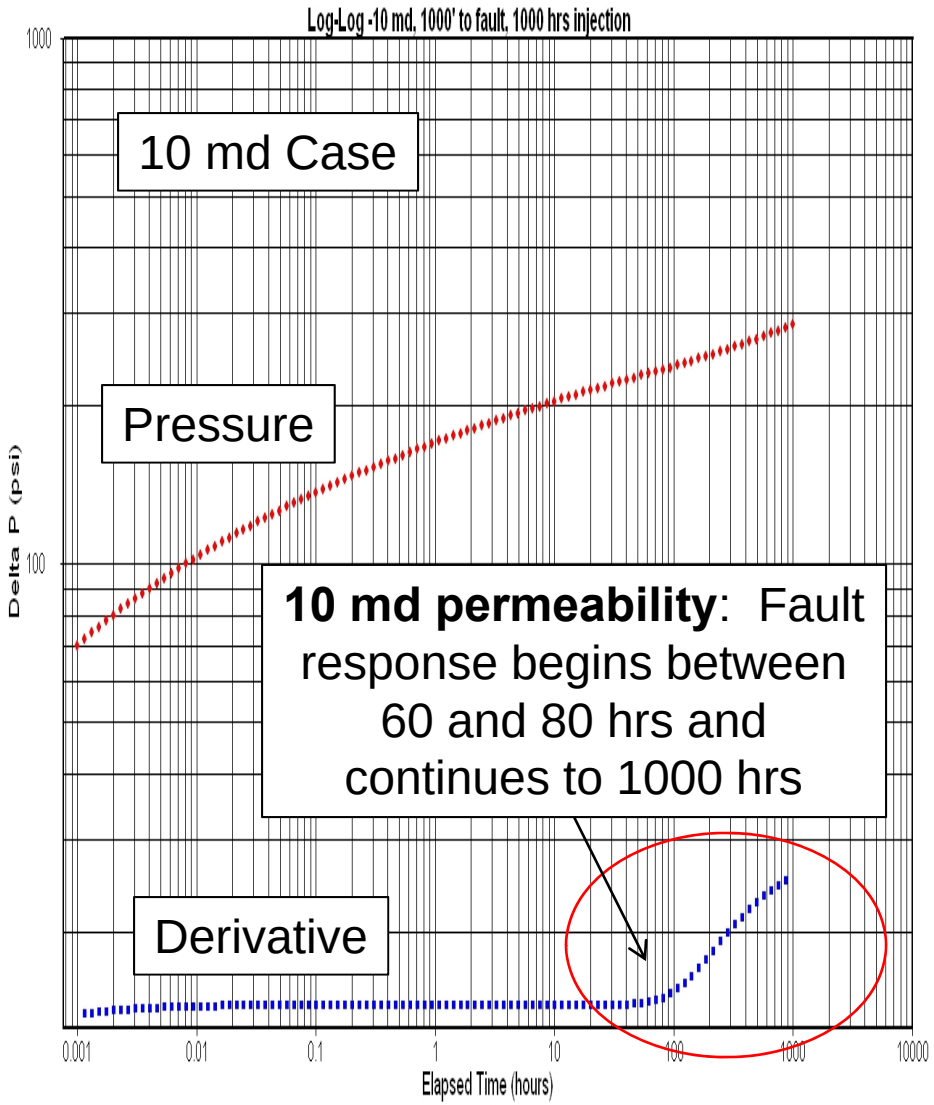
Reservoir Parameter Assumptions

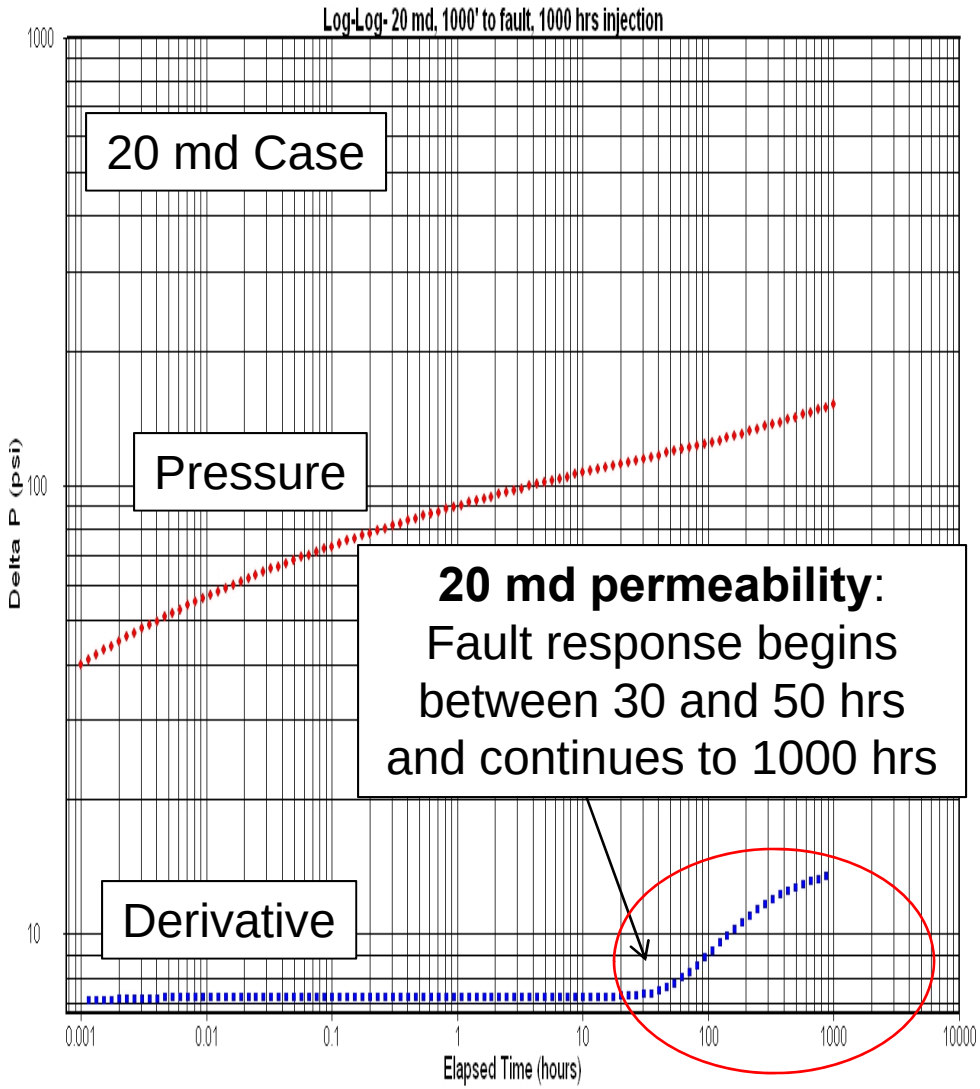
- **Stasta 1**
  - Completed in Hunton formation
  - Permeability range, k = 10 md and 20 md
    - Stasta 2 ZEI calculations
      - Arbuckle permeability = 10 md
      - Wilcox permeability = 20 md
  - Net thickness, h = 63’ (perforated interval Stasta 1)
  - Porosity, Φ = 10% (rough avg of Stasta 2 formations)
    - Stasta 2 ZEI calculations:
      - Arbuckle porosity = 7 %
      - Wilcox porosity = 12%
  - Static Pressure, P_{static} = 1890 psi calculated
    - Assumed a 200’ static fluid level, 0.465 psi/ft gradient , top of injection interval at 4264’
    - (0.465 x (4264’-200’)) – 209’ static fluid level in Stasta 2

Reservoir Parameter Assumptions for Sensitivity Study

- Fault distances: 250’ and 1000’ away from disposal well
- Injection rate = 130 BPD (based on Stasta 1 rough average of reported monthly volumes)
- No offset well effects
- Permeabilities of 10 and 20 md
- Injection times of 100 and 1000 hrs
- Falloff times of 100 and 300 hrs

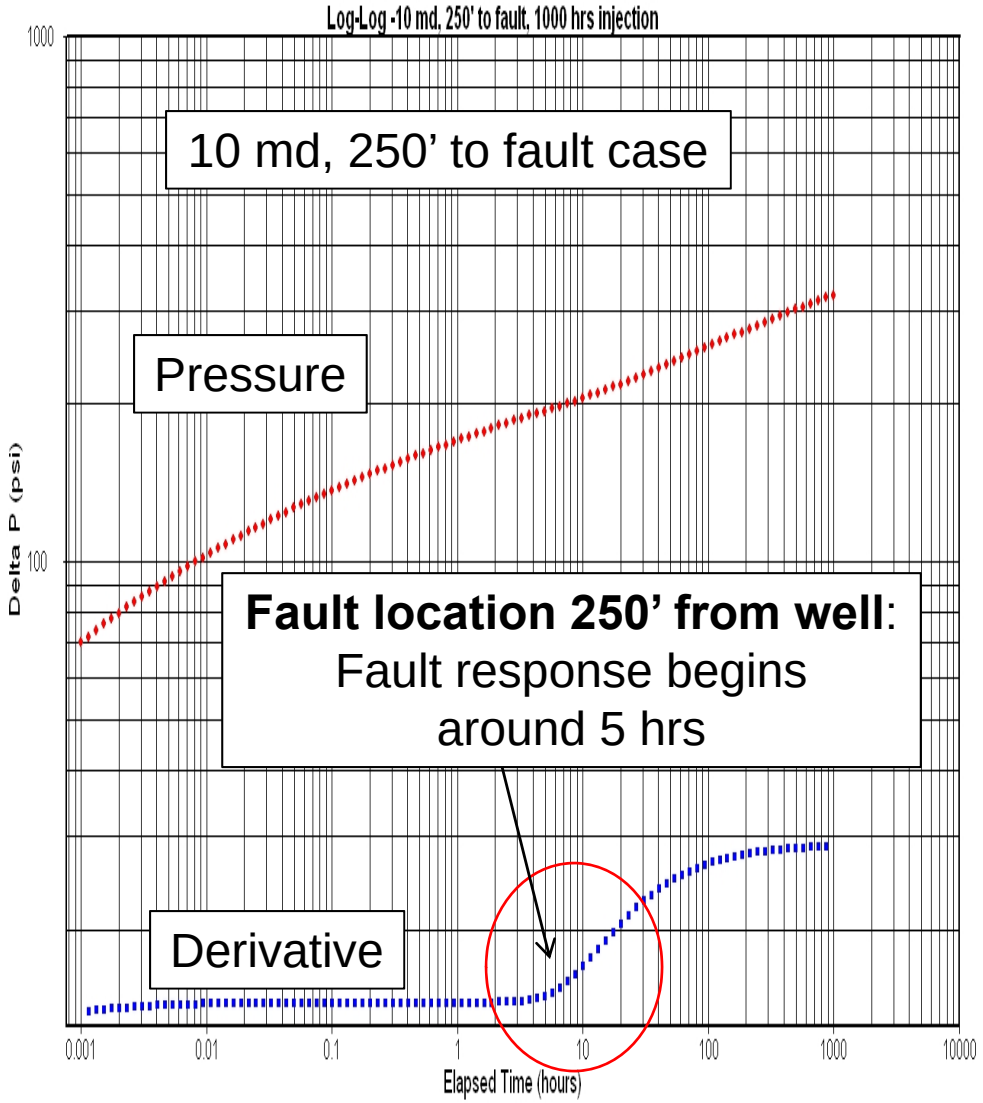
Impact of Permeability on Time to Observe Fault Response - Fault 1000’ Away, 1000 Hours of Injection

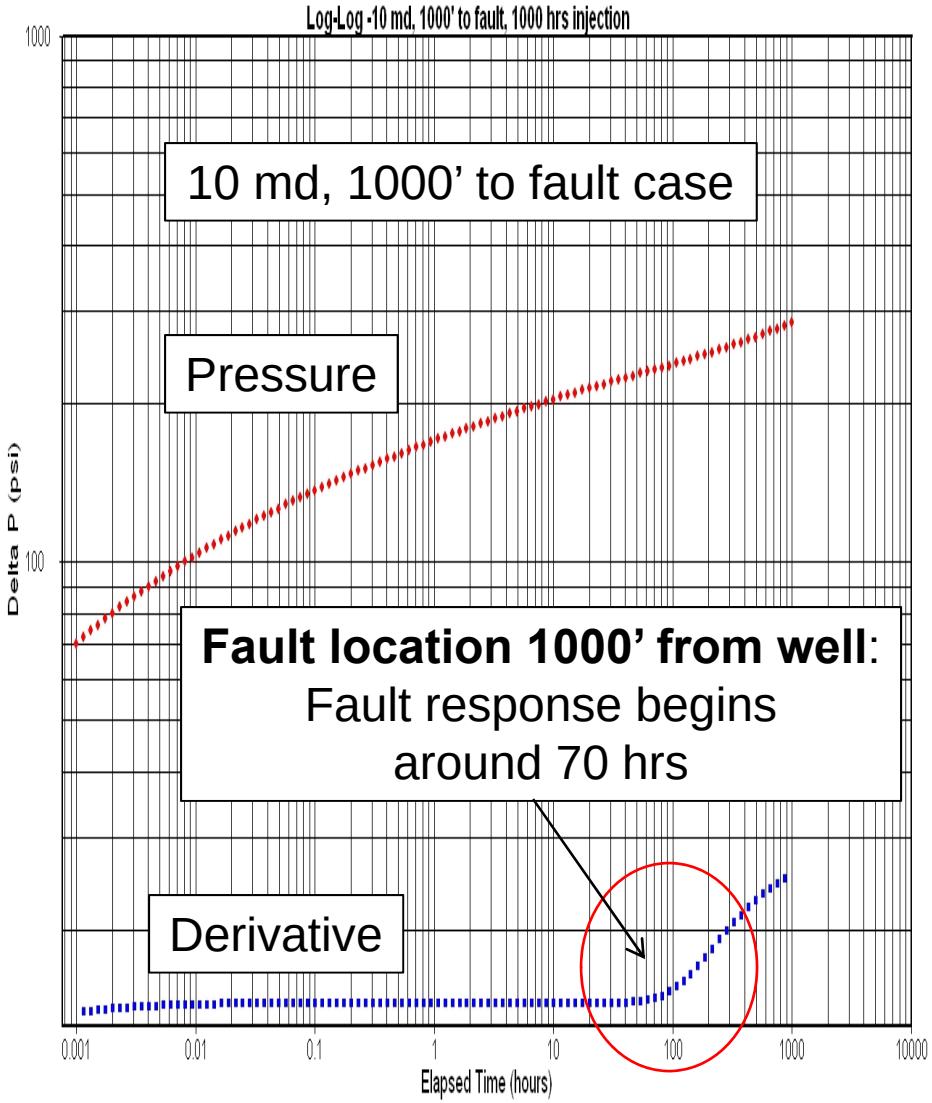




Longer injection time needed for both cases to see boundary developed during injection period. Must develop boundary during injection period to see it on the falloff test.

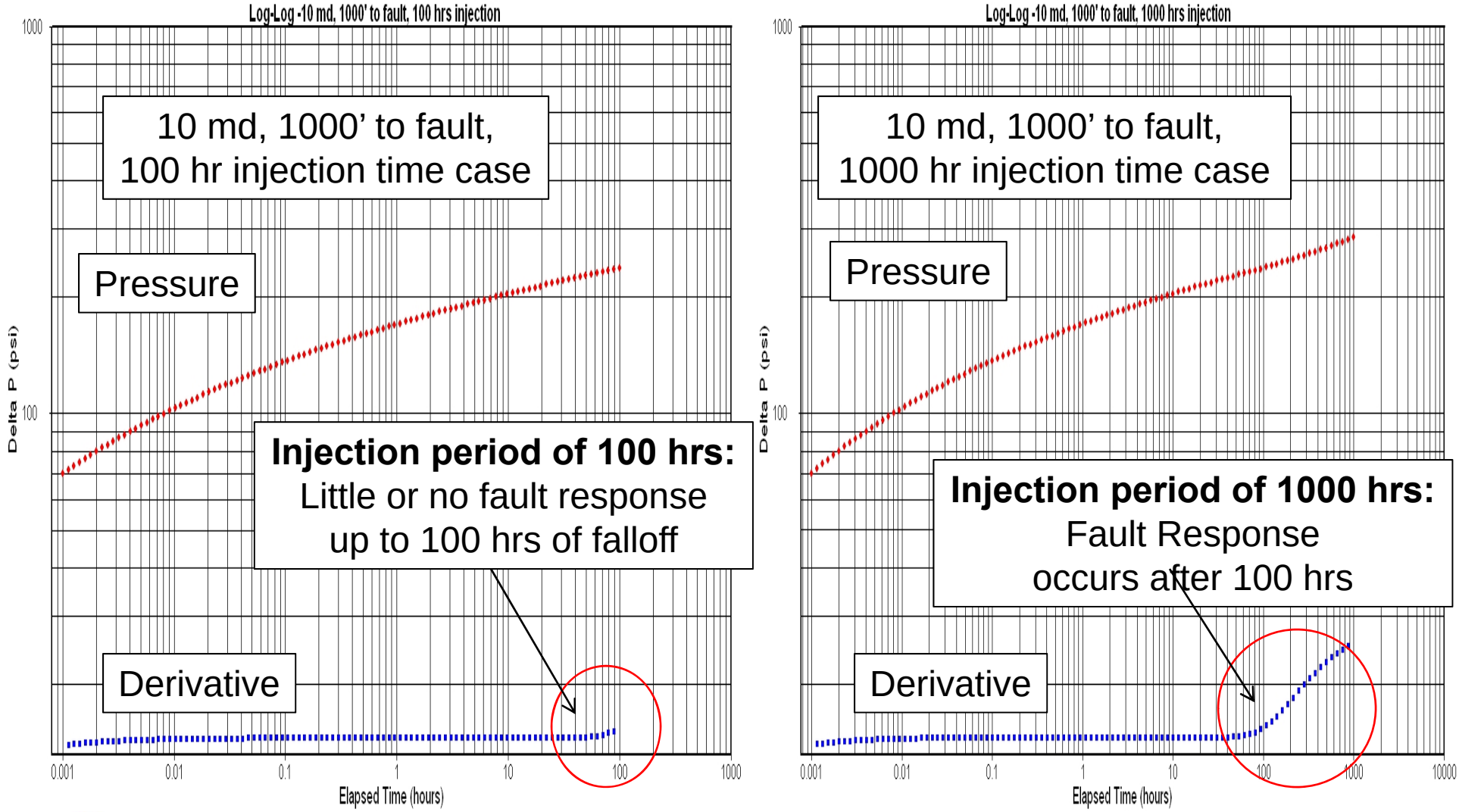
Impact of Fault Distance on Time to Observe Fault Response – 10 md, 1000 hrs Injection





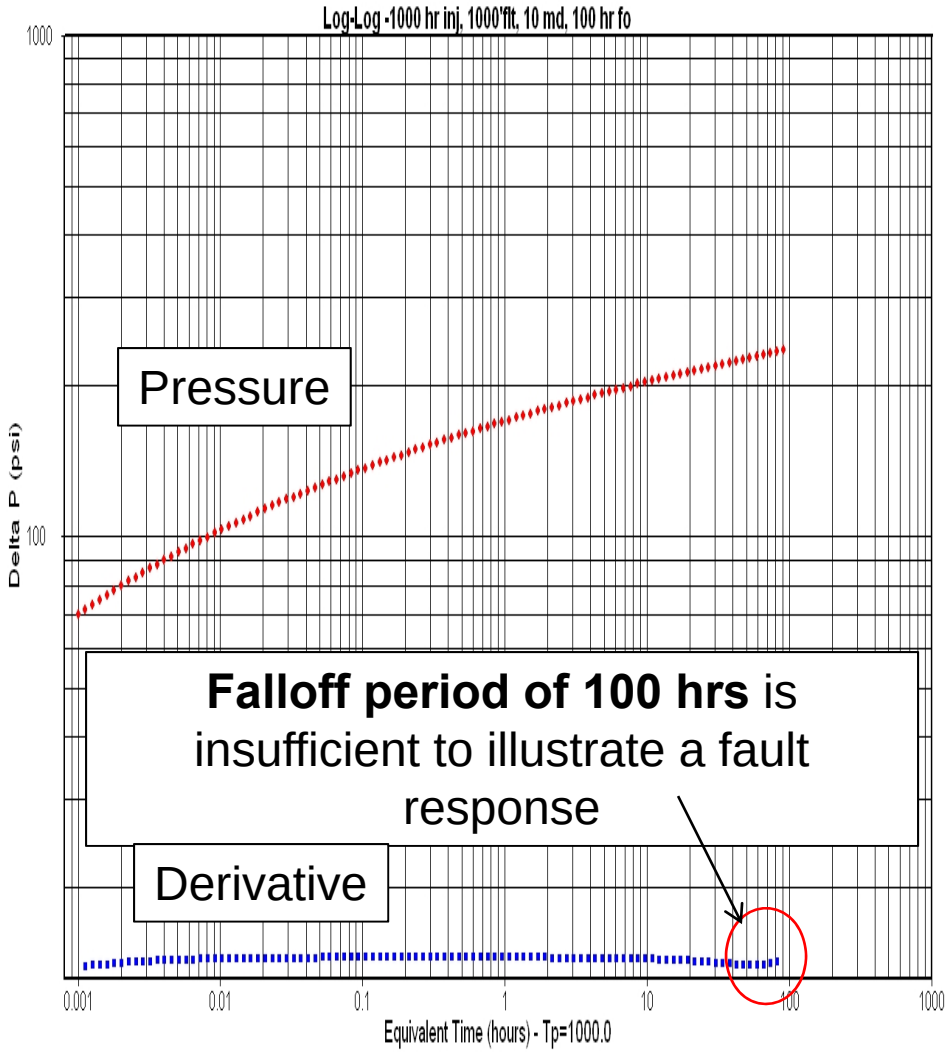
Closer fault location is observed around 5 hrs with a fault at 250' from well as opposed to 70 hrs with a fault 1000' from well

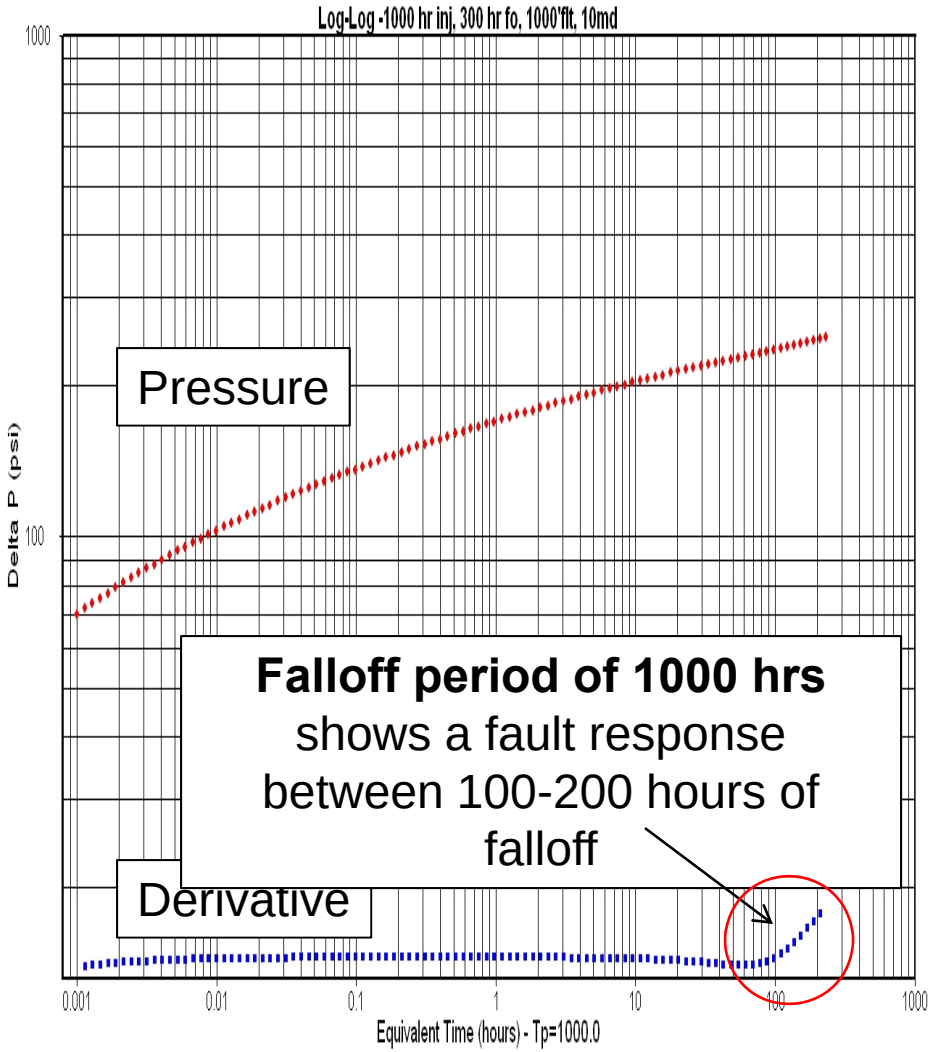
Time of Injection Impact on Observed Fault Response – 10 md, 1000’ to fault



Injection time of 100 hrs is insufficient to observe a response from a fault located 1000’ away from the well. Injection time of 1000 hrs provided an adequate response.

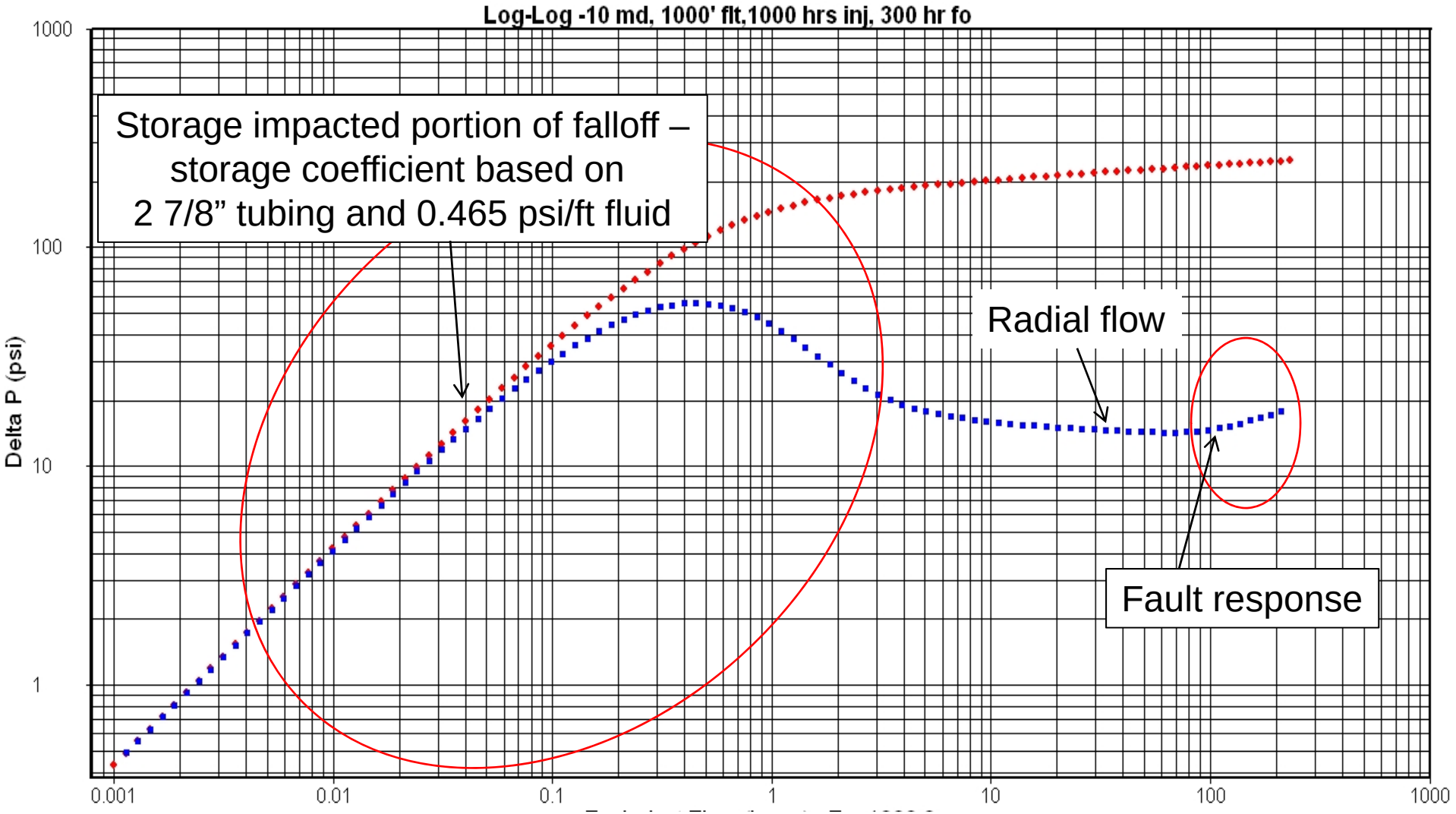
Falloff Duration Impact on Fault Response – 10 md, 1000 hrs injection, 1000’ to Fault





Using an injection time of 1000 hrs, 10 md, and fault 1000’ from well, a falloff time of 100 hrs is insufficient to observe the fault response. A falloff time of 300 hrs provided a fault response, though doubling of the slope had not occurred in this timeframe.

Falloff Response for Well on a Vacuum – 10 md, 1000’ to fault, 1000 hrs injection, 300 hrs falloff, and wellbore storage



Impact of wellbore storage, such as a well going on a vacuum, delays the reservoir response. A closer fault would result in an earlier fault response. A radial flow period preceding the response is needed to calculate the distance to the fault

Modeling Results

- A fault 250’ away is observable in a 10 md reservoir with 1000 hrs of constant rate injection and 100 hours of falloff time
  - Injection time as short as 100 hours captures much of the fault response for the subsequent falloff
- A fault 1000’ away requires a longer injection period and a long shut time (~300 hours) to obtain a definitive fault response on falloff
- Wellbore storage reduces time to observe radial flow before fault response
  - May greatly shorten time to observe radial flow if fault is closer (250’)
  - A radial flow period is needed to estimate fault distance